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Fig. 1 *Ratibida pinnata*

Prairie environments in the American Midwest

Emily Blackmore

Prairies stretched across millions of acres of north America until roughly 200 years ago, extending from Texas north into Canada, and eastward to the states hugging Lake Michigan. Early grasslands are thought to have covered parts of this region in the late Eocene epoch, about 35 million years ago; these were mostly 'cool season' grasses. Prairie 'warm season' grasses such as *Andropogon gerardii* (fig. 2) did not appear until about 10 million years ago.

The initial expansion of the prairies coincided with the last retreating glaciers, 8,000 years ago. As they retreated, the glaciers deposited thick layers of glacial till – ground-up bedrock, gravel and grit – which allowed grasses to thrive. Fine, wind-blown silt particles from relic glacial rivers, floodplains and sand dunes accumulated as powdery brown loess. The combination of glacial till and loess formed the rich black soil of the prairies, and as the post-glacial climate warmed up and dried out, grasses began to outcompete the forests and savanna shrubs that had previously dominated. Prairies continued to spread, aided by their symbiotic relationship with mammals such as elk and bison, as the ice age mammals declined and disappeared.

Paleo-Indians, and later, Plains Indians lived all across the prairie regions, using many of the plants for medicinal, spiritual, edible and ceremonial purposes. In this way, and because of the important roles of bison and fire in their culture, they helped shape the prairie ecosystems. The different tribes held fire, wind and bison as sacred offerings from the gods, and the effects on the land of fire and grazing created a dynamic mosaic of prairie vegetation to sustain them.


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Fig. 2 *Andropogon gerardii*

In the early 1800s, European settlers began crossing the prairies, and millions of acres were destroyed through conversion to agriculture, intensive grazing and urban development. The Plains Indians were either killed or relocated by the European settlers during this period, representing the loss of an important culture.

The prairie bioregion can be broadly classified into three categories: the tallgrass prairie which was predominantly the subject of my study, the richest in species diversity, and now nearly extinct (only 0.1 percent remains of the original tallgrass prairies). The soil in tallgrass is rich and fertile, with adequate rainfall in the east of the prairie expanse. Secondly, the shortgrass prairie, which is a drier composition in the west of this expanse. And then the mixed grass prairie, roughly in the centre. Within these bioregions, depending on the composition and dynamics of the pre-settlement landscape, there are wet prairies, mesic prairies, dry prairies, hill prairies, sand prairies and savannas.

The prairie ecosystem

The prairie ecosystem is a vast web of life, with microbes and fungi below ground, and plants, insects, amphibians, fish, spiders, birds and mammals above ground. I visited many relic and reconstructed prairies during my trip.

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Fig. 3 Monarch butterfly on *Heliopsis helianthoides*

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Fig. 4 Common milkweed, *Asclepias syriaca* - a symbiotic plant of the monarch butterfly

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Fig. 5 Milkweed, *Asclepias tuberosa*


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Fig. 6 Invasive saplings are kept in check by controlled burns


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Fig. 7 *Echinacea pallida*


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Fig. 8 *Veronicastrum virginicum*

These are reported on in greater detail in my full report which will be published on the HPS website in May 2020, but are beyond the scope of this article. Suffice here to say that research is being conducted at many prairie sites, including wildlife and phenology surveys by volunteers and staff, to acquire statistics on biodiversity.

There is a symbiotic relationship in the prairie between the bison and the monarch butterfly. I was fortunate enough to capture a photograph of the monarch butterfly (fig. 3), but not on the right plant! The ones in question being the native milkweeds, or asclepias species (figs 4 & 5). The population of the monarch is under threat due to habitat loss, increased use of pesticides and recent colder, harsher winters linked with climate change. The butterfly pollinates the milkweed as it feeds on the nectar, and lays its eggs on the underside of the flower. The emerging larvae feed on the leaves as they develop. Milkweeds also contain chemicals called cardiac glycosides, which are poisonous to predatory vertebrates; these are ingested by the butterfly larvae, giving them a degree of protection from being eaten.

The floral diversity of the prairies is enriched by bison, as they have a digestive system big and strong enough to process the coarse grasses which they prefer to graze on. This reduces the dominance of the grasses, and opens up space for sunlight and moisture to penetrate the ground, improving the forbs'[1] chances to survive and thrive. Bison also sharpen their horns on tree saplings, causing severe damage, and again reducing competition for the forbs (fig. 6 – in the absence of bison, saplings are kept in check by controlled burns). Herds can roam great distances, disturbing the soil with their hooves, creating pockets for seed which is caught in their hair – then shed – and so seed is dispersed across the prairies, increasing diversity. The consequences of their digestion are also an efficient method of seed dispersal, at the same time fertilising the soil with rich nutrients.

Bison historically roamed, trampled and grazed across the North American prairies in their millions. During the European settlement, they were killed for sport hunting, or to make way for cattle, which prefer to eat forbs. By 1895, fewer than 1,000 bison remained in all of North America. Bison have been reintroduced in many of the restored prairies because of the symbiotic relationship they have with the prairie, and I was lucky to view bison in the distance at one of the prairies I visited.

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Fig. 9 Dense communities of *Eryngium yuccifolium* and *Silphium terebinthinaceum* on lower ground

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Fig. 10 *Silphium laciniatum*

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Fig. 11 *S. l.* leaves point north to south

[1]A forb is a herbaceous flowering plant that is not a graminoid (grass, sedge, or rush)

Effects of environmental conditions

Variations in elevation and associated soil moisture affect the development of plants across the prairie. At one site, this was evident as *Echinacea pallida* dominated the higher elevations, and *Veronicastrum virginicum*, a moisture lover, was prevalent at lower levels (figs 7 & 8). At another site with gravelly, well-drained soils, *Echinacea pallida* again dominated the high ground, but more sparsely; *Eryngium yuccifolium* and *Silphium terebinthinaceum* densely covered the lowland (fig. 9).

Variations in soil type across the prairie affect plant growth: the same plants as mentioned above were much smaller and more sparsely distributed when moisture and nutrients were limited in a dry, sandy environment. In contrast, the mesic soil of now-restored prairies was rich in nutrients and moisture, producing a denser, richer and more diverse floral landscape; hence its popularity for agriculture prior to restoration.

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Fig. 12 *Tradescantia ohiensis*

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Fig. 13 *Tradescantia ohiensis*

Prairie Plant Adaptations

The visual impact of the prairie as a whole is overwhelming, but I found an even greater interest in looking at each individual plant, and its adaptation to the landscape. Observing the way plants adapt to their habitat confirmed to me the importance of selecting the right plants for the right environment.

The prairie is a harsh environment for plants to survive and prosper. It lies in the centre of a continent in which violent weather clashes occur: warm, moist air from the Gulf of Mexico clashes with frigid arctic air and strong swirling winds from the Rocky Mountains, resulting in extreme temperature fluctuations and brutal storms. Spring and summer winds can cause extreme drought conditions, as well as exposure to long periods of intense sunlight. Fires rage through the prairies, either caused by lightning strikes, or deliberately set by Native Americans, and now through controlled burn management. Most of the prairie grasses are fire-adapted, evolving with and benefiting from fires, which help initiate new cell growth from the apical meristem located below ground.

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Fig. 14 Hairy buds of *Silphium laciniatum*

The adaptations I noted of prairie plants to reduce transpiration, and maximise photosynthetic efficiency include:

- Reduced or increased leaf size: rolled leaves (*Schizachyrium scoparium*); smaller leaves which can be thin, linear, or rounded (*Liatris pycnostachya*); and larger leaves, particularly if basal (*Silphium terebinthinaceum*).
- Leaf positioning to minimise, or maximise, exposure: leaves pointing north to south (*Silphium laciniatum* – figs 10 & 11), and leaves which alternate on the stem (*Silphium perfoliatum*).
- Different leaf surfaces: waxy, thick leaf cuticle (*Eryngium yuccifolium*) and bumpy, rough, refracted leaves (*Heliopsis helianthoides*).
- Reflective leaf colour: glaucous, silver, grey-green leaves (*Artemisia ludoviciana* and *Tradescantia ohiensis* – figs 12 & 13).
- Hairy leaves, buds and stems: (*Silphium laciniatum* and *Echinacea pallida* – fig. 14).
- Extensive root systems: roots that penetrate up to 3.5m deep (*Amorpha canescens* and *Andropogon gerardii*)
- Intercalary meristems: apical meristem is located beneath the ground (*Sorghastrum nutans*).

It would have been wonderful to witness big bluestem (*Andropogon gerardii*) in its full glory as it can reach up to 2.7m tall, and *Liatris pycnostachya* was still in bud; but I did observe and identify many genera and species during my visit. In total, over the two weeks, I studied plants within 39 genera and 55 species. I feel my identification skills were honed during my trip, in particular paying attention to the intricacies of the adaptations of prairie plants in response to the powerful influences they are subject to. Examining plants in their natural environment without any human intervention was a rewarding experience, and it taught me to appreciate the complex relationships within plant communities, in their ecological context.

Emily Blackmore has worked in horticulture for five years, after a career change from event management. She trained at Queen Elizabeth Olympic Park, Inner Temple Garden and Royal Botanic Gardens, Kew while studying for her RHS Level 2 and 3 certificates.

Her love of ornamental hardy perennials led to this American prairie tour, funded in part by the Kenneth Black Bursary Scheme.